THE GEOLOGY OF AN AREA LYING ALONG BARTON CREEK SOUTHWEST OF AUSTIN, TEXAS

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Dean of the Graduate School.

THE GEOLOGY OF AN AREA LYING ALONG BARTON CREEK SOUTHWEST OF AUSTIN, TEXAS

THESIS

Presented to the Faculty of the Graduate School of
The University of Texas in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

By

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(Austin, Texas)
Austin, Texas

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PREFACE

This project was undertaken at the suggestion of Dr. F. L. Whitney, to whom the writer is deeply grateful for the assistance and advice which he has given in the progress of the work. The writer also wished to express his appreciation to Dr. E. H. Sellards and Professor F. B. Plummer for their interest and suggestions in preparing the report.

Free acknowledgement is made of the use of outside material. Full credit for all material used is given in the proper place.

CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

The area to be described in this report lies along Barton Creek southwest of Austin, Texas. The Austin-Oak Hill highway passes through it. It extends from a point five-eighths of a mile southwest of the city limits of Austin on this highway in a southwest direction for a distance of two and three-eighths miles. From a point just east of Kouns on the Missouri Pacific Railroad it extends northwest for a distance of four and five-eighths miles. The accompanying diagram (Plate I) shows the exact location of the area.

The field work on which this report is based was done during the fall of 1933 and spring of 1934. The mapping was done by the reconnaissance method. A portion of the U. S. Geol. Survey topographic sheet of the Austin Quadrangle was enlarged four times and used as a base map. In a few cases plane table traverses have been made properly to locate certain features. Special emphasis has been placed on the faulting of the area, which lies in the Balcones fault zone.

INDEX MAP SHOWING LOCATION OF

AREA SHOWN IN GEOLOGIC MAP

PLATE I

DEPARTMENT OF THE INTERIOR
ALBERT B. FALL, SECRETARY
U.S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

TOPOGRAPHY

TEXAS
AUSTIN QUADRANGLE

ENGRAVED OCT 1897 BY U.S.G.S.

Henry Gannett, Chief Topographer
E. M. Douglas, Topographer in charge
Triangulation by E. M. Douglas
Topography by T. M. Bannon and W. B. Corse
Surveyed in 1895-96

Bannon
Corse
Bannon

Scale $\frac{1}{125000}$

1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 25 feet.

Datum is mean sea level.

Edition of Mar. 1910, reprinted 1921.

Note: *In joining San Marcos use dotted projection corners.*

1. PHYSIOGRAPHY

Relief

The relief of the area under discussion is moderate. In the southeastern portion it is a rolling plain, while to the northwest in the valley of Barton Creek the topography becomes more rugged. The maximum relief of the area is about 400 feet. The minimum elevation, as given on the topographic sheet of the Austin Quadrangle, is just under 500 feet, and the maximum is about 900 feet. The cycle of erosion may be said to be in a late youthful stage. The hills are nearly flat on top, while the valleys are deep and abrupt. Cliffs have formed along the streams as a result of rapid erosion. Fault scarps are not prominent, though the topography rises from east to west as a result of faulting.

Drainage

Although Barton Creek drains most of the area, Williamson Creek passes through a small southern portion of it. Both creeks flow into Colorado River to the northeast. Bouldin Creek drains a small part on the eastern edge.

Vegetation

Much of this area is covered by cedar brakes, a growth

which is quite widespread west of the Balcones fault zone. In many places this growth has become a problem to the stockmen, since it grows rapidly and is very dense, destroying grasses suitable for grazing.

On some of the flats of the region, particularly those resulting from the erosion of Eagle Ford and Del Rio clays, mesquite is found. Large live-oak trees are found on the Austin chalk, and these may sometimes be used in determining the underlying formation where it is covered by a soil mantle. These trees are usually best developed on this formation, though they may extend elsewhere.

Exposures

Good exposures of the various formations are to be found along Barton and Williamson creeks, where rapid erosion has resulted in the formation of cliffs and bluffs. In much of the flat upland area the exposures are poor, and they are often obscured by a soil covering. The underlying formations may also be covered by Tertiary gravels.

It will be noted that the formations in the area in general become progressively older from east to west. This was brought about by the faulting and in some measure by the regional southeast dip of the beds.

The beds lie nearly horizontal, though due to the faulting, the dips at times become somewhat varied in direction

and amount. Small folds may be seen occasionally in the more competent beds, such as those of the Edwards formation, but they are of no importance.

2. STRATIGRAPHY

In the vicinity of Austin there are to be found strata ranging in age from Cretaceous to Eocene, the latter occurring in the southeastern portion of the quadrangle. In addition to these formations, there is also to be found a series of stream gravels and upland conglomerates of Tertiary and Quaternary age.

These formations rest on a basement of Paleozoic or older rocks, which are not known to outcrop in the Austin area, but are known from the Central Mineral Region, and from a few wells that have penetrated them in this region.

The wells, drilled in the western part of Travis County, reveal a dark, non-calcareous shale underlying the Cretaceous strata. Any attempt to place exactly the age of these dark shales is untimely at present, due to the limited knowledge of them, and a lack of fossils. There is evidently a vast unconformity between them and the overlying Cretaceous. At Luling, Texas, the drill encountered crystalline schists beneath the Travis Peak. At Round Mountain, Blanco County, the writer has observed Cretaceous strata resting on rocks

of Cambrian or Ordovician age. It seems probable from the meager evidence that early Paleozoic and pre-Cambrian formations underlie the region between these points, including the Austin area.

Cretaceous System

Strata of Cretaceous age form the chief surface outcrops in the area shown on the map. It will be noted that certain formations are missing in this area. This is due to the effects of faulting. Since they are known to exist in nearby localities, they will be described.

The classification which will be followed in this paper is taken, with certain modifications, from the one given by Hill and Vaughan.[1] Plate II gives both the original classification of Hill and Vaughan and the one followed here. Adkins[2] gives a classification in which he splits certain of the formations into much smaller units, but as they are not readily mappable units in the area in which this work was done, they will be neglected here.

The Cretaceous system, which in Texas has been divided

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[1] Hill, R. T., and Vaughan, T. W., Geologic Atlas of the United States, Austin Folio No. 76, U. S. Geol. Survey, p. 3, 1902.

[2] Adkins, W. S., The Geology of Texas, vol. I, Stratigraphy, University of Texas Bull. 3232, Pt. 2, "Mesozoic Systems," pp. 270-1, 1932.

Series	Group	Formations (Hill and Vaughan)	Formations (Present usuage)
Gulf	Montana	Webberville formation	Navarro
		Taylor marl	Taylor
	Colorado	Austin Chalk	Austin
		Eagle Ford formation	Eagle Ford
	Dakota	(Missing)	Woodbine?
Comanche	Washita	Buda limestone	Buda
		Del Rio clay	Del Rio
		Georgetown	Georgetown
	Fredericksburg	Edwards limestone	Edwards
		Comanche Peak limestone	Comanche Peak
		Walnut clay	Walnut
	Trinity	Glen Rose formation	Glen Rose
		Travis Peak	Travis Peak

CLASSIFICATION OF CRETACEOUS STRATA IN THE VICINITY OF

AUSTIN, TEXAS

Plate II

into the Comanche and Gulf series, rests unconformably on Paleozoic or older rocks, and is overlain unconformably by Eocene strata in the Austin quadrangle. In general, the strata of this system were deposited by seas that invaded from the south and east. Marine fossils are often quite abundant.

Comanche Series

The name Comanche was first applied by Hill[3] in 1887. In 1900 Hill[4] included in this series the strata of the Western Cross Timbers belt and the Grand Prairie belonging to the Trinity, Fredericksburg, and Washita groups. Adkins[5] in 1932 emended this definition to include also the Neocomian strata now known in the western part of the state which are pre-Travis Peak.

In Travis County the Comanche lies with a vast unconformity on pre-Mesozoic rocks, and is overlain unconformably by the strata of the Gulf series. It is characterized by a

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[3] Hill, R. T., "The Topography and Geology of the Cross Timbers and Surrounding Regions," Am. Jour. Sci., vol. 3, No. 33, pp. 291-303.

[4] Hill, R. T., "The Geology and Geography of the Black and Grand Prairies, Texas," U. S. Geol. Survey 21st Ann. Rept., vol. VII, p. 128.

[5] Adkins, W. S., The Geology of Texas, vol. I, Stratigraphy, University of Texas Bull. 3232, Pt. 2, "Mesozoic Systems," p. 273, 1932.

succession of calcareous sands at the base, followed by limestone interbedded with more or less argillaceous material. The Del Rio is exceptional in that it is nearly pure clay.

a. Trinity Group

The term "Trinity Division" was first used by Hill[6] in 1889, and the following definition was given by him in 1900:[7]

> This division includes the lower or initiatory beds of the Cretaceous formations of the Texas region, embracing all the rocks lying below the Walnut beds of the Fredericksburg division.

In the Austin Section, two formations are recognized in this group. These formations are the Travis Peak and the Glen Rose.

Travis Peak formation.--Hill[8] describes the Travis Peak formation as the series of sands typically occurring in the vicinity of the Travis Peak post-office in western Travis County. It is here defined as including all the strata of Cretaceous age lying on the basement rocks and underlying the lower limestone of the Glen Rose. In the Austin section

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[6] Hill, R. T., "A Check List of the Invertebrate Fossils from the Cretaceous Formations of Texas," University of Texas, Science of Geology, pp. xiv-xv, 1889.

[7] Hill, R. T., "The Geology and Geography of the Black and Grand Prairies, Texas," U. S. Geol. Survey 21st Ann. Rept., vol. VII, p. 129, 1900.

[8] Ibid., p. 140; p. 144.

it consists typically of sands, conglomerates, and some shale and limestone. It is about 263 feet in thickness at the type locality.

Hill[9] divided this formation into the following beds at the type locality near Travis Peak:

Travis Peak formation (Hensell sands
(Cow Creek bed
(Sycamore sands

The Sycamore sands consist of conglomerate and cross-bedded sands. According to Hill[10] they are the lowest outcropping beds of the Cretaceous east of Pecos River. These beds range around 50 feet in thickness, and form the lower main Trinity artesian water reservoir. They grade upward from coarse conglomeratic material at the base into finer clastics above.

The Cow Creek beds are of an impervious nature. They are some 30 feet thick at Travis Peak, but thicken toward Austin, as indicated by well logs. In some places these beds are quite fossiliferous, containing a characteristic fauna. Perhaps the most distinctive fossil found in them is the ammonite, Dufrenoya texana Buckhardt. The following fossils commonly occur in these beds:

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[9] Ibid., p. 135.

[10] Ibid., p. 142.

Cyrena arkansasensis Hill
Astarte pikensis (Hill)
Orbicella travisensis Wells
Cucullea gracilis Cragin
Ostrea damelina Cragin
Trigonia spp.

The Cow Creek beds are usually grayish-white in color, and are for the most part limestone. They outcrop along Pedernales River, where their peculiar weathering has resulted in the formation of such scenic spots as Hamilton's Pool, West cave, and Dead Man's Hole. Cuyler[11] reports a thickness of 56 feet for these beds at Cox's Crossing on Pedernales River.

The Hensell sands, which typically consist of red to yellowish sands and clays, form an artesian water reservoir at Austin. They include all the beds lying between the Cow Creek beds and the basal limestone beds of the Glen Rose. Hill[12] recorded a thickness of 143 feet for the Hensell sands on Hickory Creek, with some 40 feet of strata intervening between them and the Glen Rose. Cuyler[13] states that there is an arenaceous limestone occurring near the top which is

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[11] Cuyler, R.H., The Travis Peak Formation of Central Texas, Dissertation, p. 47, 1931.

[12] Hill, R.T., "The Geology and Geography of the Black and Grand Prairies, Texas," U. S. Geol. Survey 21st. Ann. Rept., vol. VII, p. 141, 1900.

[13] Cuyler, R.H., op. cit., p. 52.

constant in occurrence.

At a point 4.2 miles west of Pedernales River on the Austin-Marble Falls highway the writer has observed a zone of great abundance of the foraminifer, Orbitolina texana (Roemer). Associated with this fossil is a large oyster, Ostrea whitneyi.[14] Cuyler[15] regarded this zone as 17 feet below the top of the Travis Peak formation. Exogyra bullardi[16] occurs in the upper portion of the Hensell sands.

The Travis Peak formation is the chief artesian water reservoir along the Balcones fault zone. Several other zones of water are known which occur higher in the section, but in none of these is there an abundant flow such as that of the Travis Peak. It is generally believed that the numerous large springs which occur along the Balcones fault zone derive their water from the Travis Peak formation. During the summer of 1932, the writer observed a phenomenon in connection with Barton Springs which was interesting. The season had been dry, and the springs were falling off in their flow. The water that was flowing was exceedingly clear. A hard rain occurred, and Barton Creek rose moderately, but soon dropped. Within 24 hours the flow of the springs was doubled,

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[14] Cuyler describes this form in his Dissertation.

[15] Cuyler, op. cit., p. 99.

[16] Cuyler describes this form in his Dissertation.

and the water was so muddy as seriously to impair the swimming pool for several days. This murkiness of the spring water continued for some time, slowly clearing up. The flow of water remained sustained at the higher figure, dropping off only slightly later. The explanation for this apparent close relationship of rainfall to flow would seem to be that the water of the springs is entering through fault fissures a short distance up the creek. This is further borne out by the fact that the creek flow is usually smaller, or even wanting, just above the springs, than it is some distance up the creek.

The depths of the wells drilled to the Travis Peak artesian water in or near Austin vary somewhat, depending on the location in relation to the faulting, but they average around 2000 feet.

Glen Rose formation.--The name Glen Rose was first applied by Hill[17] in 1891. The type locality is near Glen Rose, Texas.

Near Austin, the formation consists of impure argillaceous to arenaceous limestone beds alternating with softer marly layers. These alternating beds may run from a few inches to many feet in thickness. The formation is typically

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17 Hill, R. T., "The Comanche Series in the Texas-Arkansas Region," Bulletin of the Geology Society of America, vol. II. pp. 502-504, 1891.

white to yellowish in color.

The upper contact of the formation is placed at the top of the upper sand bed, just under the massive limestone beds bearing the Walnut fauna. This thin sand bed probably represents a remnant of the Paluxy. There are several places near Austin where a conglomerate separates the Glen Rose and the Walnut. One place where this may be seen to advantage is just west of Bull Creek.

The Glen Rose formation weathers in a very characteristic manner, particularly in its upper portions, where it develops terraced slopes caused by the alternation of hard and soft beds. The heavier and more massive beds in the lower portion frequently produce bold cliffs.

The Glen Rose formation thickens rapidly to the south and east. Whitney[18] reports that the thickness of the beds lying above the Salenia texana horizon is comparatively constant in central Texas, though the total thickness of the formation varies greatly. This indicates a progressive overlap of the beds as the sea spread over the area, and is strong evidence of an unconformity separating the Glen Rose and Travis Peak formations.

There are several paleontologic zones which can be

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[18] Whitney, F. L., personal interview, Austin, Texas, March, 1934.

determined in the Glen Rose formation. One of the most persistent is the Salenia texana zone mentioned above. This zone consists of a horizon of clays containing Salenia texana Credner, Hemiaster comanchei Clark, Enallaster obliquatus Clark, Nerinea sp., and Corbula sp., which are immediately overlaid by a limestone of some 6 inches thickness which has a characteristic brownish color and is sometimes called the "key rock," because it forms a good bed for structural work.

Such genera as Monopleura, Toucasia, Trigonia, Arctica occur commonly, and Orbitolina texana (Roemer), Porocystis globularis (Giebel), Cucullea terminalis Conrad are widely distributed in this formation.

The Glen Rose formation in the central part of Texas has a thickness along the outcrop of from 500 to around 800 feet. In the Blunn Creek well in Travis Heights the Glen Rose has a thickness of more than 800 feet.[19] Underground toward the coast it is probably as much as 4500 feet thick.

Celestite occurs in scattered pockets near the base, in the middle, and in the top of the formation. At Mount

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[19] Adkins, W. S., Geology of Texas, vol. I, Stratigraphy, Pt. 2, "Mesozoic Systems," University of Texas Bull. 3232, p. 317, 1932.

Bonnel these deposits in the top of the formation may be seen to advantage.

This formation outcrops on the northwestern margin of the area shown in the map. It has been brought up by faulting, and lies in contact on the surface with the Edwards formation. This fault is the major fault of the Balcones zone. The Glen Rose may be expected underground throughout the rest of the area, and a thickness comparable to that of the Blunn Creek well may be expected.

b. Fredericksburg Group

Hill[20] in 1887 included strata down to the Travis Peak in his Fredericksburg division, but later his Trinity division was made to include the Travis Peak and Glen Rose. The type locality is Fredericksburg, Texas. This is a rather unfortunate choice, since the strata are poorly developed at this locality.

The Fredericksburg group includes all the strata lying above the top of the Trinity group and below the Washita group. Considerable confusion has resulted from the complex assortment of facies represented in this group, and due to the fact that general faunal breaks seem to be absent between

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[20]Hill, R.T., "The Topography and Geology of the Cross Timbers and Surrounding Regions of Northern Texas," Am. Jour. Sci., vol. 3, No. 33, p. 298, 1887.

the formations. Hill, in a footnote about the Comanche Peak and Edwards, says:[21]

> In casting up the knowledge of the limestone of the Fredericksburg division it has occured to him that it might be better to extend the term Edwards to it as a whole, inasmuch as the other names used are but subdivisions of what practically constitutes an unbroken formation.

Adkins says:[22]

> Although in this discussion the Fredericksburg is divided into the conventional formations, it is the writer's opinion that all formations in this group should be suppressed and only the facies used. However, a decision on this procedure can be reached only after the zonation is better known and the meaning of the term "formation" better clarified.

Hill and Vaughan[23] assigned a thickness of 15 feet to the Walnut in the vicinity of Austin and defined it as the marly strata lying above the Glen Rose and below the chalky limestone they called the Comanche Peak. They placed the top of the Glen Rose at the top of a series of limestones containing such fossils as Tylostoma pedernales (Roemer),

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[21] Hill, R. T., "The Geography and Geology of the Black and Grand Prairies, Texas," U. S. Geol. Survey 21st Ann. Rept., vol. VII, p. 214, 1900.

[22] Adkins, W. S., The Geology of Texas, Vol. I, Stratigraphy, University of Texas Bulletin 3232, Pt. 2, "Mesozoic Systems," p. 323, 1932.

[23] Hill, R. T., and Vaughan, T. W., Geologic Atlas of the U. S., Folio 76, U. S. Geol. Survey, 1902.

Exogyra texana Roemer, and Protocardia texana Conrad. These beds are now included in the Walnut formation. Their Comanche Peak, and that of other workers, is regarded as being in part at least the middle limes of the Walnut, with the possible exception of some 10 to 15 feet of chalky limestone at the top, which is probably Comanche Peak. The upper Walnut marls are missing in the Austin area.

Walnut formation.--The Walnut was named by Hill[24] in 1891. The formation does not outcrop on the area shown on the map, due to the effect of faulting. In nearby outcrops north of Colorado River it contains the following characteristic fossils:

Exogyra texana Roemer
Protocardia texana Conrad
Gryphaea marcoui Hill and Vaughan
Cyprimeria texana Roemer
Porocystis globularis? (Giebel)
Holectypus planatus Roemer
Enallaster texanus (Roemer)
Tylostoma pedernales (Roemer)
Salenia mexicana Schlüter
Turritella seriatim-granulata Roemer
Metengonoceras hilli (Böhm)
Oxytropidoceras acutocarinatum (Shumard)
Pseudodiadema texana Clark
Neithea irregularis (Böse)
Engonoceras pierdenale (von Buch)

In addition to these fossils there occur many others.

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[24] Hill, R. T., The Comanche Series of the Texas-Arkansas Region, Geol. Soc. America Bull. 2, p. 512, 1891.

The Walnut fauna is one of the richest of the entire section. Some very interesting forms which occur in the middle Walnut limestones belong to several species of verticellate algae. They are preserved as moulds in the crystalline limestone, have peculiar corn-cob like markings, and are about 1 millimeter in diameter and some 5 to 8 millimeters long. There are probably 6 species of this form. There are a number of foraminifera which occur in the Walnut, though the only one which is sufficiently well known to be of any stratigraphic value is Orbitolina (Dictyocunnus?) walnutensis (Carsey). This form is found in the Walnut clays and marls, and it may be identified in thin sections of the Walnut limestones. A somewhat similar form of a new species is found in the Comanche Peak.

The Walnut formation begins in a series of limestones some 10 feet thick, passes into about 30 feet of alternating marls and limestone beds, followed by the middle Walnut limestone, which ranges up to 110 feet thick at Cedar Park, and these in turn followed by another series of marls. The greatest thickness the writer has observed near Austin is at Cedar Park, where a section 165 feet thick was measured. The section is between 65 and 80 feet thick at Austin, the upper marls being missing.

Comanche Peak formation.--The name Comanche Peak was

first used by Shumard[25] in 1860. The type locality is at Comanche Peak, Hood County. The formation consists of a chalky limestone which probably represents a gradational facies between the Walnut and Edwards. It contains a fauna essentially similar to the Walnut, though perhaps the general faunal aspect may be slightly changed.

This formation has not been recognized in the area mapped. Both it and the Walnut probably underlie much of the area, and may be expected in drilling work.

Edwards formation.--The name Edwards was first applied to this formation by Hill and Vaughan[26] in 1898, replacing the names "Caprina limestone" and "Barton Creek limestone." The type locality of the Edwards is on Barton Creek, in the area shown on the map. Here the formation includes the strata lying above the Comanche Peak and below the Georgetown. The Kiamitia formation, which farther north overlies the Edwards, is wholly missing in the Barton Creek section. The Edwards formation presents a series of hard crystalline limestones containing flint in nodules and layers. The

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[25] Shumard, B. F., "Observations on the Cretaceous Strata of Texas," Proc. St. Louis Acad. Sci., Trans. I, pp. 283-585, 1860.

[26] Hill, R. T., and Vaughan, T. W., "Geology of the Edwards Plateau and Rio Grande Plain Adjacent to Austin and San Antonio, Texas," U. S. Geol. Survey 18th Ann. Rept., Pt. 2, 1898.

thickness of the beds varies somewhat, there being much heavily bedded, massive limestone, with some phases assuming a flaggy character, particularly toward the top. In west Austin the upper part is marked by the Austin marble, a bed of crystalline limestone containing many calcitized fossils, which has been used for building stone.

The fauna of the Edwards is of an unusual type. The following forms are most commonly present:

Toucasia patagiata(White)
Toucasia texana (Roemer)
Caprina crassifibra Roemer
Ichthysarcolites anguis Roemer
Eoradiolites davidsoni(Hill)
Monopleura pinguiscula White
Monopleura marcida White

There are often many foraminifera belonging to the genus Miliola in the limestone beds of the Edwards. Oxytropidoceras belknapi (Marcou) has been observed in the upper part of the formation in west Austin, and other common Fredericksburg fossils occur through it.

A rather extensive erosional surface is known to occur at the top of the Edwards. This surface may be clearly seen on Bear Creek at Manchaca, Texas, and it seems quite possible that it may extend as far north as Austin.

There is a widespread horizon of sulphur water in the top of this formation, and oil is produced from it at Luling, Salt Flats, and several other localities.

Brucks[27] states that the upper portion of the Edwards is dolomitic at Luling, with a porosity ranging from 5 to 30 per cent. He suggested that the porosity resulted from the shrinkage attendant upon dolomitization.

Sellards[28] reports the occurrence of dolomitic ledges 1 mile south of Duval along the Missouri Pacific Railroad in Travis County.

The following section, taken from Hill, shows the character of the Edwards along Barton Creek:[29]

(a) Upper part of Edwards limestone exposed in bluffs of Barton Creek, about 1 mile above bridge.

Edwards limestone:	Ft.	In.
49. Nodular limestone, full of requienias	3	0
48. Nodular limestone, nodules as large as one's head	2	0
47. Hard, chalky limestone	3	0
46. Thinly laminated limestone (the so-called "Lithographic flags")	8	9
45. White, sublimated, chalky limestone. The lower parts of Nos. 45 and 46 contain many fossils, Exogyra texana, Pholadomya knowltoni, etc.	8	5
44. Nodular limestone, no requienias	1	0

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27 Brucks, E. W., "The Luling Oil Field, Caldwell and Guadalupe counties, Texas," The Structure of Typical American Oil Fields, Vol. I, A. A. P. G., p. 274, 1929.

28 Sellards, E. H., Mineral Resources of Texas, Travis County, Bur. of Econ. Geol., Univ. of Tex., p. 51, 1930.

29 Hill, R. T., "The Geography and Geology of the Black and Grand Prairies, Texas," U. S. Geol. Survey 21st Ann. Rept., vol. VII, p. 232, 1900.

	Ft.	In.
43. Nodular limestone with many requienias (second requienia bed)	3	9
e. Laminated limestone	1	0
d. A series of hard limestone ledges (eight in number) separated by thinly laminated layers. There are some flints about as large as a man's fist. - Radiolites and O? munsoni	45	8
c. Flaggy layer with discoidal flints	2	4
b. Hard limestone, forming a shelf along this portion of Barton Creek and its bottom at the bridge below, eroded in deep potholes. The lower 2 feet of this layer contains very large blue flints, often 1 foot across. Some of them are oval, others flattened out and very irregular in outline. The upper part of the bed contains small flints.	12	8
a. Limestone ledges with some flattened flints. All the flints in this section belong to the blue variety.	11	0
Base of a is bed of Barton Creek		
Total thickness of strata in bluff	171	11

Fault in Edwards formation on Barton Creek, about 1 mile above Barton Springs.

Hill evidently made an error in the total of this section, since by adding the figures given a total of 102 feet 7 inches is obtained. Eifler[30] reports, however, that the upper Requienia bed (No. 49) of Hill's section is not the top of the Edwards. Since writing his thesis he has found a red layer some 10 feet thick containing definite Edwards fossils above the Requiena bed. Whether this is the top of the Edwards is subject to question.

c. Washita Group

Shumard[31] used the name "Washita limestone" in 1860. He mentions various fossils in it, which indicate that it was the formation now called Georgetown. Hill[32] elevated this term to a group name. The Washita is the highest group of the Texas Comanche series. It has been divided into a number of formations in north Texas, but in central Texas only three are recognized. These formations are the Georgetown, Del Rio, and Buda. The Washita is about 200 feet in thickness in Travis County, and ends in the unconformity

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30 Eifler, G. K., Personal communication, May 11, 1934.

31 Shumard, B. F., "Observations on the Cretaceous Strata of Texas," St. Louis Acad. of Sci., Trans. I, p. 583, 1860.

32 Hill, R. T., "The Topography and Geology of the Cross Timbers and Surrounding Regions, Texas," Am. Jour. Sci., (3) 33, p. 298.

which marks the top of the Comanche series. The group is made up of two limestone beds separated by a clay formation in central Texas.

Georgetown formation.--The Georgetown formation is the lowest occurring member of the Washita group in central Texas. It is named from Georgetown, Texas, where it is typically exposed along San Gabriel River.

The formation consists of alternating layers of impure hard limestone and marls which at Austin rest on the Edwards formation. It is about 80 feet in thickness there, and weathers yellowish white in color. Cuyler[33] has shown that horizons may be established in it which correlate with the Duck Creek, Ft. Worth, Denton, Weno, and lower Mainstreet formations in north Texas. He states that the Paw Paw formation of the north Texas section is missing at Austin.

Since the formation forms a lithologic unit, it has been mapped as such. No attempt has been made to determine the various zones in detail.

The most common fossils of the Georgetown are as follows:

Holaster simplex Shumard
Desmoceras brazoensis (Shumard)
Mortoniceras (Pervinquieria) tri-nodosa (Böse)
Gryphaea whasitensis Hill

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33 Cuyler, R. H., "The Georgetown Formation of Central Texas and its North Texas Equivalents," Am. Assoc. Petroleum Geol. Bull. 13, p. 1294, 1929.

Hamites comanchensis Adkins and Winton
Mortoniceras (Pervinquieria) wintoni (Adkins)
Mortoniceras (Pervinquieria) leonensis (Conrad)
Hemiaster elegans Shumard
Exogyra americana Marcou
Alectryonia carinata (Lamarck)
Kingena wacoensis (Roemer)
Neithea georgetownensis Kniker
Neithea texana (Roemer)
Pleurotomaria macilenta Cragin

The foraminifera of the Georgetown are similar to those found in the overlying Del Rio clay, though the presence of small orbuline bodies will serve to distinguish this formation. Some of the more common foraminifera are:

Globigerina washitensis Carsey
Textularia washitensis Carsey
Textularia rioensis Carsey
Anomalina falcata Reuss
Lenticulina washitensis (Carsey)
Dentalina communis d' Orbigny
Gyroidina nitida (Reuss)

Del Rio formation.--The name Del Rio was first applied by Hill and Vaughan[34] to strata in the vicinity of Del Rio in 1895. Near Austin this formation attains a thickness of about 80 feet. It consists of a bluish laminated clay which weathers to form a dull yellow slope and finally a black soil. The formation contains considerable pyrite, and often the weathered fossils will be coated with an iron oxide.

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[34] Hill, R. T., and Vaughan, T. W., "The Geology of the Edwards Plateau and the Rio Grande Plain adjacent to Austin and San Antonio," U. S. Geol. Survey 18th Ann. Rept., Pt. 2, p. 236, 1898.

Sometimes the freshly exposed fossils appear golden with a pyrite covering. Selenite is present in joints and seams. Hill[35] believes this to be due to the oxidation of the pyrite present and deposition as sulphate by reaction with the lime of shells present.

This formation apparently rests conformably on the Georgetown limestone, and is overlain by the Buda limestone. It is often covered by a dense growth of mesquite. It is one of the most easily recognized formations in the entire Comanche series, and may be spotted at a distance because of its peculiar yellow color in weathered slopes. When wet, the clay is very plastic, and considerable trouble has been encountered at Austin due to this characteristic. Ornamental stone walls built on its steep slopes will creep downhill and collapse, and trouble has been experienced with house foundations. On the Barton Springs road there are several places where repeated slumping of the Buda, and even landslides of minor proportions, occur following heavy rains.

There are a number of characteristic fossils in this formation. In the lower portion there is a zone of great abundance of the fossil Exogyra arietina Roemer. In the upper portion there occurs a zone of Gryphaea mucronata

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35 Hill, R. T., "Geography and Geology of the Black and Grand Prairies, Texas," U. S. Geol. Survey 21st Ann. Rept., Vol. VII, p. 284, 1900.

Gabb which extends up into the Buda.

Other commonly occurring fossils are:

Neithea subalpina (Böse)
Hemiaster calvini Clark
Cymatoceras texanus (Shumard)
Engonoceras bravoense (Böse)
Turrilites brazoensis Roemer

The foraminifera found in the Del Rio formation are as follows:

Haplostiche texana (Conrad)
Gaudryinella delrioensis Plummer
Textularia rioensis Carsey
Textularia washitensis Carsey
Dentalina communis (d'Orbigny)
Lenticulina washitensis (Carsey)
Lagena sulcata (Walker and Jacobs)
Anomalina falcata (Reuss)
Globigerina cretacea d'Orbigny
Globigerina washitensis Carsey

Buda formation.--Vaughan[36] first used the name Buda, applying it to the Vola limestone of earlier writers. The formation is approximately 42 feet in thickness at Austin, and may be seen typically exposed along Shoal Creek.

The formation may be divided into two phases, the lower of which is a compact, obscurely bedded, hard chalky limestone. The upper phase is a hard nodular limestone, and is

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36 Vaughan, T. W., "Reconnaissance of the Rio Grande Coal Fields in Texas," U. S. Geol. Survey Bull. 164, p. 18, 1900.

separated from the lower by an abrupt line. One peculiarity of the formation is the presence of pink specks, giving the limestone a "burnt" color. This pink color is particularly prominent in the upper beds, and is believed to be due to the presence of glauconite which breaks down to iron oxides.

Whitney,[37] Shattuck,[38] and a number of other workers have done considerable work on the fauna of this formation at Austin, so that it is well known. There are a number of species which are peculiar to this formation. In the lower chalky beds on Williamson Creek in the area shown on the map, there occurs an abundance of the fossils Cymatoceras texanus (Shumard), Trigonia emoryi Conrad and other species. In the upper beds there is an abundance of Neithea roemeri (Hill).

The following fossils occur commonly in the Buda:

Turritella budaensis Shattuck
Budaiceras mexicanum Böse
Budaiceras texanum Shattuck
Budaiceras roemeri (Lasswitz)
Budaiceras evae (Lasswitz)
Budaiceras frechi (Lasswitz)
Budaiceras hyatti (Shattuck)
Gervillopsis invaginata White
Homomya budaensis Whitney
Neithea roemeri (Hill)

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[37] Whitney, F. L., "The Fauna of the Buda Limestone," Trans. Texas Acad. Sci., Vol. XII, pt. I, 1913.

[38] Shattuck, G. B., "The Molusca of the Buda Limestone," U. S. Geol. Survey Bull. 205, 1903.

Remondia hilli Whitney
Granocardium budaensis Shattuck
Gryphaea mucronata Gabb
Pinna sp. Whitney
Nerinea volana Cragin

The formation may be easily recognized in thin section by the presence of the pink splotches, and by the presence of Guembelina sp. Orbuline bodies are generally absent.

2. Gulf Series

The name Gulf series was first used by Hill[39] in 1887. This series may be defined as including all the strata above the base of the Woodbine and below the base of the Midway. Both the upper and lower contacts are unconformable, though the extent of the breaks is still debatable. The series outcrops in Texas along the region just east of the Balcones fault zone which Hill[40] has called the Black Prairie. In north Texas the Woodbine formation forms the Eastern Cross Timber belt.

The series is characterized by the unconsolidated character of the sediments, and the presence, particularly in

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[39] Hill, R. T., "The Topography and Geology of the Cross Timbers and Surrounding Region," Am. Jour. Sci., (3) 33, p. 298, 1887.

[40] Hill, R. T., "The Geography and Geology of the Black and Grand Prairies, Texas," U. S. Geol. Survey 21st Ann. Rept., p. 65, 1900.

the upper portion, of much marl. It was due to the black soils resulting from the weathering of the Taylor and overlying Navarro formations that the name Black Prairie was derived. These formations are very thick, and in central Texas they are underlain by the Austin chalk and Eagle Ford shales. The presence of a black shale at the base of the Gulf in Austin which bears some evidence of unconformable relation to the overlying Eagle Ford has led some workers to regard this shale as representing the Woodbine of the north Texas section.

a. Colorado Group

Eagle Ford formation.--This formation was named by Hill[41] after Eagle Ford, Dallas County, in 1887. It consists of a series of bituminous laminated shales alternating with yellowish sandy limestone and bentonite layers. At Austin it rests directly on the Buda limestone, and marks the base of the Gulf series. A good exposure of the formation may be seen along Bouldin Creek about 1 mile north of the area mapped.

The Eagle Ford is characterized by the presence of large numbers of fish remains, particularly teeth, and by the

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41 Hill, R. T., "The Topography and Geology of the Cross Timbers and surrounding Regions, Texas," Am. Jour. Sci., III, p. 296, 1887.

flaggy arenaceous limestone beds alternating with bentonite and shales. The more common fossils found in these beds in central Texas are:

Ostrea lugubris Conrad
Ostrea alifera Cragin
Exogyra columbella Meek
Inoceramus fragilis Hall and Meek
Inoceramus aff. problematicus Schluter
Inoceramus aff. labiatus Schlotheim
Scaphites n. sp.
Acanthoceras aff. cornutum Kossmat
Fish teeth
Plant remains

This formation is concealed by faulting and Tertiary gravels in the area mapped. It is about 40 feet in thickness, the lower 15 of it being a black shale containing much pyrite. This shale shows ripple marking near its top, and sponge spicules are commonly found in it.

The following micro-fauna is most commonly found:

Guembelina globulosa (Ehrenberg)
Guembelina globifera (Reuss)
Anomalina eaglefordensis Moreman
Anomalina falcata (Reuss)
Globigerina cretacea d'Orbigny
Globotruncana arca Cushman

Austin formation.--Shumard[42] applied the name Austin limestone in 1860. The type locality is at Austin, Texas.

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[42] Shumard, B. F., "Observations on the Cretaceous Strata of Texas," Proc. St. Louis Acad. Sci., Trans. I, p. 583, 1860

The Austin chalk consists of poorly bedded, soft white chalk and softer marl. The chalk has an earthy texture, and weathers in concoidal flakes. In many places the formation contains pockets of iron pyrite and marcasite. These occur as spherical concretions with a radial structure up to 2 inches in diameter, and on weathering stain the white chalk. Thin sheets of iron oxide are sometimes seen along the joints.

Most of the major cities along the Balcones escarpment are built on this formation. It weathers to form a black soil, which is usually not deep, and may be so shallow on hill tops as to leave the white chalk in evidence. Large live-oak trees are frequently found on it.

The Austin rests unconformably on the Eagle Ford and is overlain by the Taylor marl. In the area shown on the map, it is cut by an igneous intrusion, which will be discussed later.

The Austin chalk is characterized by the presence of an abundance of Inoceramus casts, Gryphaea aucella Roemer, Exogyra ponderosa Roemer, Exogyra laeviuscula Roemer, and Mortoniceras texanum (Roemer). The following fossils occur rather commonly:

Mortoniceras texanum (Roemer)
Durania austinensis (Roemer)
Ostrea aff. diluviana Lamarck
Exogyra laeviuscula Roemer

Exogyra tigrina Stephenson
Exogyra ponderosa Roemer
Gryphaea aucella Roemer
Inoceramus undulato-plicatus Roemer
Cucullea n. sp.
Neithea austinensis Kniker
Pecten bensoni Kniker
Hemiaster texanus Roemer

The Austin formation is the highest marine formation outcropping in the area mapped and probably only the basal portion is represented here. Sellards[43] reports a thickness up to 400 feet for this formation in the Austin area. The formation is rich in foraminifera, the following forms being most common:

Kyphopyxa christneri (Carsey)
Lenticulina rotulata Lamarck
Eponides micheliniana d'Orbigny
Dorothia bulletta (Carsey)
Rectoguembelina texana Cushman
Guembelina globifera (Reuss)
Anomalina falcata Reuss
Globotruncana arca (Cushman)

Tertiary System

No marine strata of the Tertiary system are known to outcrop in the area mapped. Eocene strata are known, however, in the southeastern portion of the Austin quadrangle. Overlying the Cretaceous in the area shown on the

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[43] Sellards, E. H., Mineral Resources of Texas: Travis County, Univ. of Texas Bur. Econ. Geol., 1930.

geologic map there occurs a series of stream gravels and upland conglomerates which are regarded as Tertiary and Quaternary in age.

Uvalde formation.--In 1891, Hill[44] applied the name Uvalde to the upland conglomerate deposits known in central and south Texas. In the area mapped they occur at elevations between 650 and 700 feet above sea level, and form a plateau south of Barton Creek.

The Uvalde is characterized by a great abundance of flint, particularly in the western part, and by boulders from the underlying Cretaceous. In the west it has been noted that Edwards fragments predominate, whereas farther east the Buda furnished the material.

The formation varies greatly in character over small areas, changing in a distance of 1/2 mile from a rounded gravel deposit with calcareous material to a tightly cemented conglomerate of more or less angular fragments. In some places it may be mistaken for the underlying Cretaceous, since it weathers into a black rocky soil with residual boulders of the Cretaceous.

The thickness of the Uvalde may range from a few feet to 20 or more feet, and it typically occurs on the stream

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[44] Hill, R. T., "Notes on the Geology of the Southwest," Am. Geologist, VII, p. 368, 1891.

divides.

The only fossils observed by the writer were those derived from reworked Cretaceous material, and others have reported an absence of diagnostic fossils. Plummer[45] believes this formation to be Pliocene in age.

IGNEOUS ROCKS

On the Missouri Pacific Railroad, 3 1/8 miles south of the Colorado River bridge, near Kouns station, there occurs a disturbance of the Austin formation, and rocks which are believed to be igneous in origin are present. These rocks are apparently a volcanic mud flow, and contain inclusions of Austin chalk. They are soft, brown in color, and have a vesicular appearance. The Austin formation and the strata of the mud flow apparently interbedded with it are deformed into a dome-like structure, somewhat sililar to that found at Pilot Knob. This fact leads the writer to the belief that a basaltic sub-surface core may exist.

Austin fossils are found[46] in a similar occurrence in Travis Heights. This would indicate that the probable age

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[45] Plummer, F. B., The Geology of Texas, vol I, Stratigraphy, Univ. of Texas Bull. 3232, Pt. 3, "Cenozoic Systems", p. 779, 1932.

[46] Whitney, F. L., Personal communication, April 1934.

of the activity was late in Austin time. Lonsdale[47] concluded that there were two periods of igenous activity along the Balcones fault zone. One of these he regarded to be Cretaceous (Eagle Ford or Austin-Taylor Age) and the other Tertiary.

The igneous rocks of this area were probably of the Austin-Taylor period of activity.

GEOLOGIC STRUCTURE

The area shown on the map lies in the Balcones fault zone. This zone of faulting consists of a series of parallel or sub-parallel step faults, usually with the downthrow to the east. It may be traced from the Rio Grande at Del Rio through points just west of San Antonio, Austin, and Waco to as far north as Dallas. It is one of the major structural features of Texas, and finds topographic expression in the Balcones escarpment. South of Austin it divides the Coastal plain and the Edwards plateau, and as far north as Temple the Lampasas cut plain lies west of it.

At Austin the faults of this system generally strike north 30° east. The writer has estimated that the total displacement between the western and eastern edges of the

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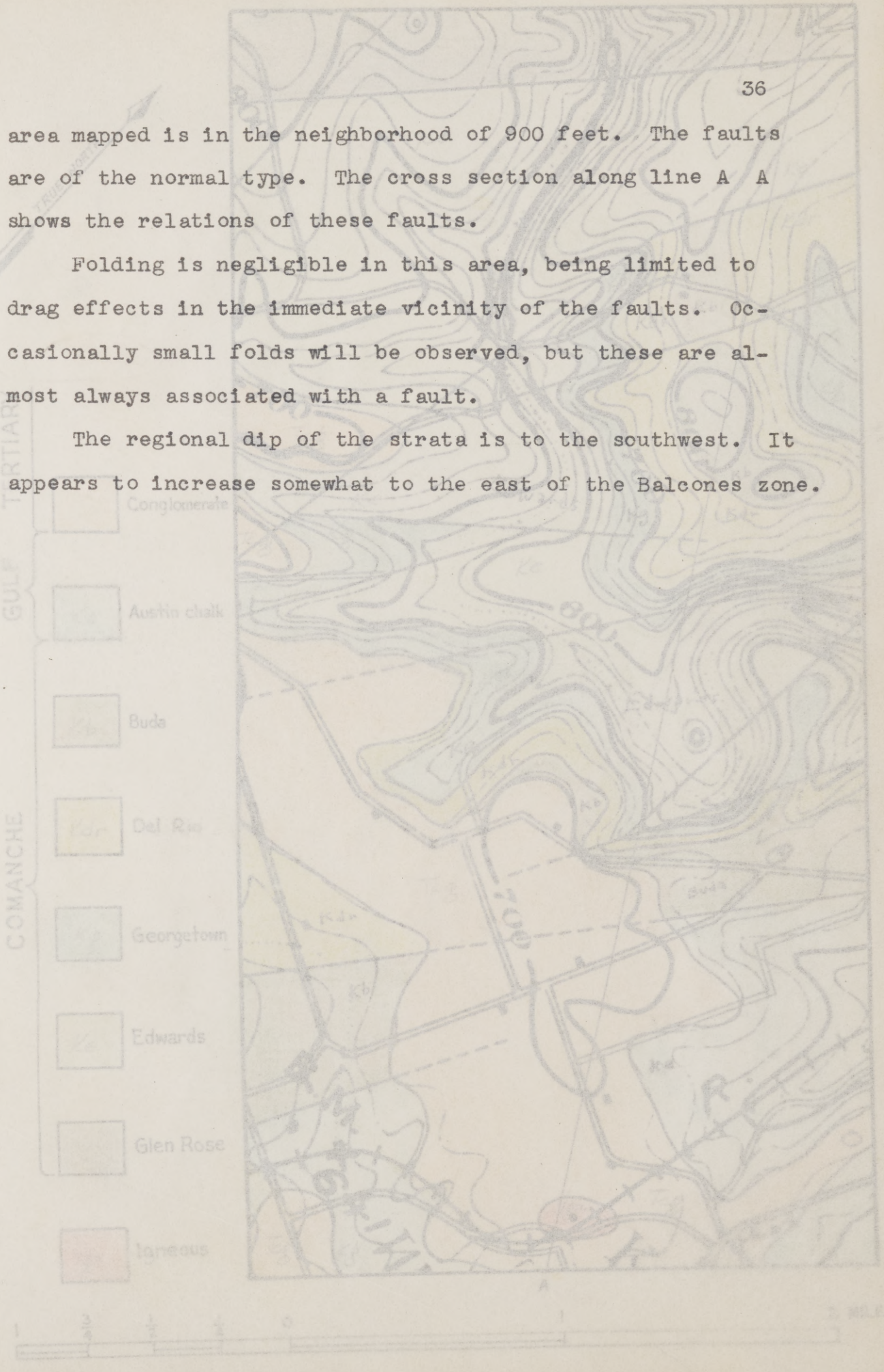
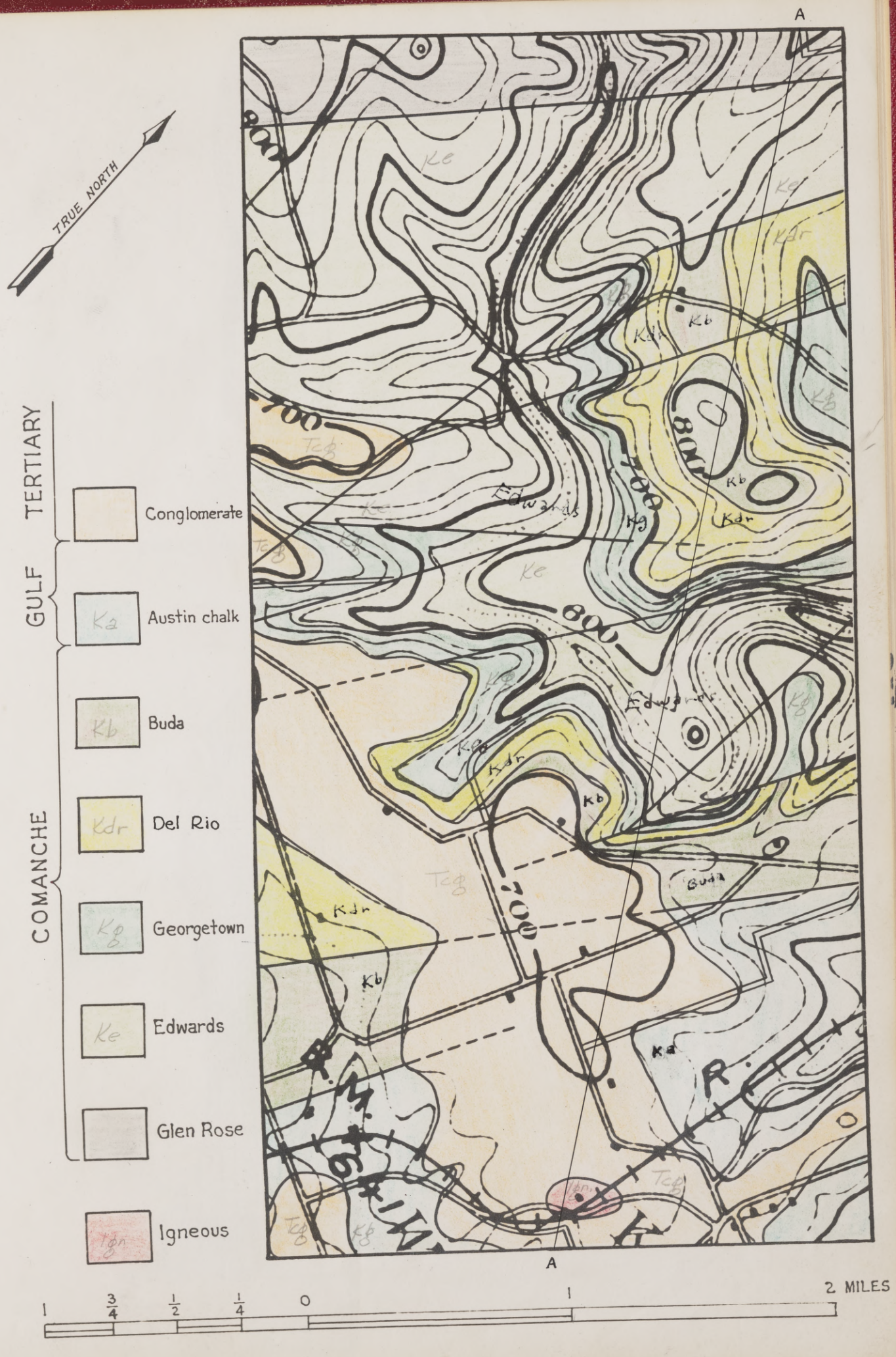
[47] Lonsdale, J.T., Igneous Rocks of the Balcones Fault Region of Texas, Univ. of Texas Bull. 2744, p. 46, 1927.

area mapped is in the neighborhood of 900 feet. The faults are of the normal type. The cross section along line A A shows the relations of these faults.

Folding is negligible in this area, being limited to drag effects in the immediate vicinity of the faults. Occasionally small folds will be observed, but these are almost always associated with a fault.

The regional dip of the strata is to the southwest. It appears to increase somewhat to the east of the Balcones zone.




TRUE NORTH
TERTIARY
GULF
COMANCHE
Conglomerate
Austin chalk
Buda
Del Rio
Georgetown
Edwards
Glen Rose
Igneous
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Kb
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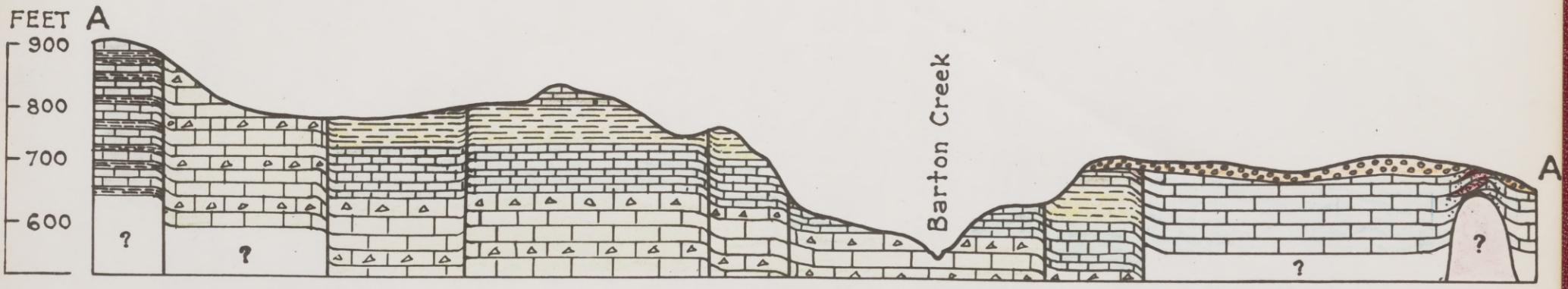

CROSS SECTION ALONG LINE A-A

Horizontal Scale: 1 Inch = 2547 Feet
Vertical Scale: 1 Inch = 250 Feet

PLATE IV

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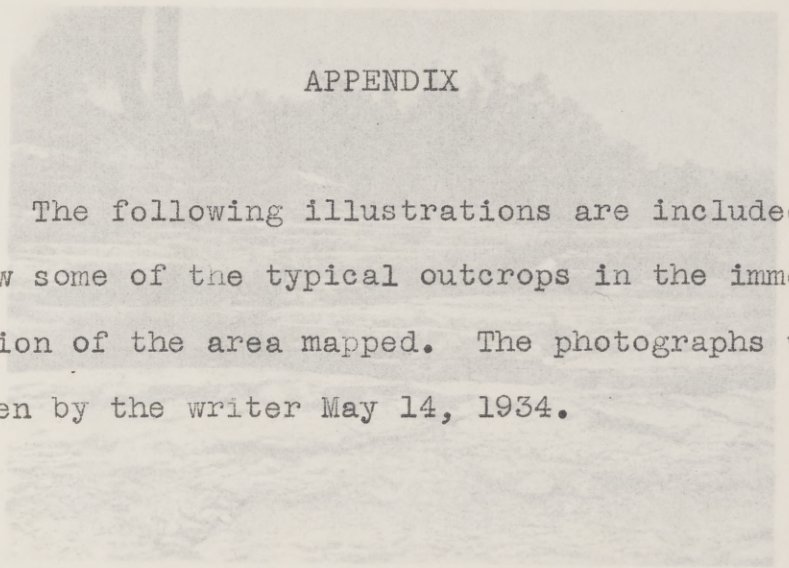
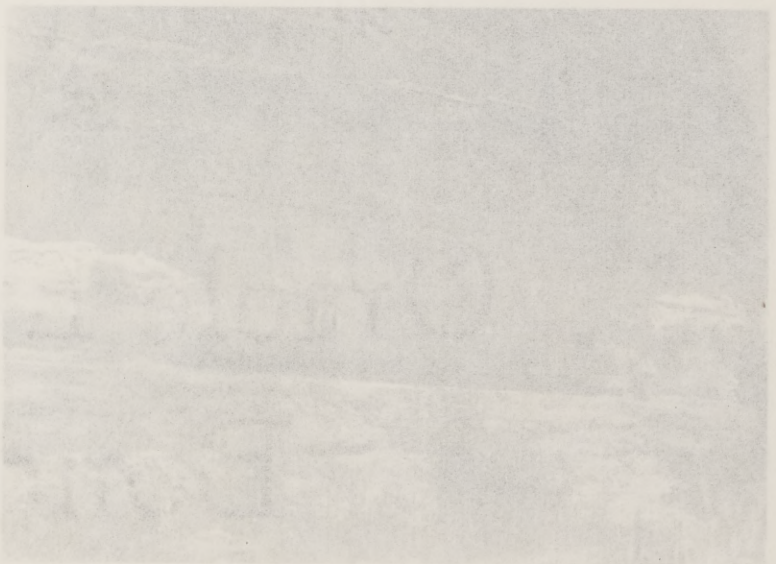
APPENDIX

The following illustrations are included to show some of the typical outcrops in the immediate region of the area mapped. The photographs were taken by the writer May 14, 1934.



"Lithographic flags" of the Edwards just above entrance to Barton Springs.



Massive beds of Edwards, about ½ mile above Barton Springs.

"Lithographic flags" of the Edwards just above entrance to Barton Springs.

Massive beds of Edwards, about $\frac{3}{4}$ mile above Barton Springs.

Typical outcrop of lower Buda limestone in the bed of Williamson Creek, looking east from Manchaca highway. These beds are quite fossiliferous at this locality.

A Del Rio slope on the Barton Springs road, showing the slumping of the Buda limestone. Sliding after heavy rains has caused trouble at this point on this road.

View of Uvalde conglomerate lying on Austin chalk. The Uvalde here is about 1 foot thick, and is made up of tightly cemented fragments of Buda and Edwards. Picture taken at cut in road about ½ mile east of water tower on Manchaca road.

Gravel pit on San Antonio highway, opposite Woodward Body Works. Note the great thickness of the deposit at this point. This is believed to be Uvalde conglomerate.

View of igneous rocks in cut along Missouri Pacific Railroad near Kouns station.